Indication of an Unusual change in the Arctic's Late-summer Sea Ice Thickness-volume Relationship

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Variations and trends in sea ice thickness during 1982–2003 are investigated using neural networks that estimate thickness for all 25 km x 25 km ice-covered pixels in the Arctic Ocean based on a spatially explicit retrospective characterization of each pixel's dynamic and thermodynamic environment. Using sea ice motion data, the monthly position of each pixel is followed in reverse-chronology for up to 3 years, and at each location, data for 7 environmental parameters describing short and longwave radiation fluxes, surface air temperature, ice drift velocity, and ice divergence/convergence are accumulated and used by neural networks to estimate the pixel's ice thickness. The networks were learned with data from *in situ* submarine draft and surface drilling measurements. Average January ice thickness increased in most regions of the Arctic during 1982–1988 (+7.6±0.9 cm yr^{-1}, S>99%), then decreased in almost all regions through 1996 (-6.1±1.2 cm yr^{-1}, S>99%), and then modestly increased through 2003 (+2.1±0.6 cm yr^{-1}, S=99%), primarily in the central Arctic. Late-summer ice thickness and volume show a recent and unusual departure in their relationship. September ice thickness and volume changed more or less proportionally until the mid-1990s, but then through 2002, thickness increased while volume remained constant. This diverging relationship indicates a state of disequilibrium, since thickening cannot indefinitely compensate volume under conditions of declining ice extent. Timing of the recent thickening trend is congruent with purported decadal-scale oscillations, suggesting natural processes may have already instituted a sea ice regime shift, but its expression has been confined to the central Arctic by changes in thermal forcing at lower latitudes.